NECESSITY OF INVOLVEMENT OF CALIBRATION LABORATORIES IN PROFICIENCY TESTING SCHEMES

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Abstract:
During the accreditation, but also in its maintenance, calibration laboratories must prove their competence. According to the ISO/IEC 17025:2005 standard competence is proved by participating in interlaboratory comparisons or participation in PT (proficiency testing) schemes. However, some accreditation bodies, such as Serbia, insist on participation in PT schemes and not accredit calibration laboratory, or even take away accreditation, unless they are involved in these activities. Of course, participation in interlaboratory comparisons is default.

Unfortunately, PT schemes are not organized for all types of measure and methods as there are no accredited PT providers (for example - for the geodetic measures are not any). To some measures there is only one provider of PT, and if there are any more they charge for their services, which are not negligible. In such situations calibration laboratory located in a very difficult situation because they can not obtain or may lose accreditation.

On the other hand, participation in interlaboratory comparisons, according to the standard, also proves competence, but are easier to maintain and less costly - usually do not cost anything because all involved laboratories have the same benefit. Also, these activities can be organized between laboratories in the same state.

This paper aims to stimulate discussion and debate about ways of proving competence of calibration laboratories. We believe that, in the interpretation of ISO/IEC 17025, the laboratory can demonstrate competence by participating in any activity, PT schemes or interlaboratory comparisons, and they are equal to this need.

Keywords: PT schemes, calibration laboratory, certification, competence

1. INTRODUCTION

According to the rules of accreditation, calibration laboratories must constantly prove their competence. Proving of competence conducts appropriate accreditation body, which issued a certificate of accreditation. If the laboratory does not meet certain requirements may lose accreditation, partially or in whole.

Accreditation body in the supervision of calibration laboratories comply with the standard by which issued the certificate of accreditation, ISO/IEC 17025, and other supporting documents, for example. EA-4/18 TA: 2010 - Guidance on the level and frequency of proficiency testing participation. However, in some cases, within the accreditation body, the individual requirements of the standard are interpreted in different ways by which the laboratory lead in a competitive disadvantage because they do not know who assessor will come in supervision. One of the demands which interpreted differently, which is increasingly foregrounds of the demonstration of competence, is participation in PT (proficiency testing) schemes. The second, also important and the similar requirement, participation in interlaboratory comparisons is placed in the background, ie. should participate in this activity, but it is not enough just that.

Both of these activities are carried out along similar principles - calibration one and the same measurand by different laboratories. The difference between these activities in some cases it may be only in the number of participants. Therefore, it seemed questionable why he insisted on PT schemes in cases where there are no providers for specific measurand, or measurand characteristics.

2. DEMONSTRATION OF COMPETENCE

Maintenance of accreditation for calibration laboratories depends on many factors, and among them, perhaps most significant, is demonstrate competence through participation in interlaboratory comparison and PT schemes.

In ISO/IEC 17025:2005 standard, chapter ***5.9 Assuring the quality of test and calibration results***, it is stated: "*The laboratory shall have quality control procedures for monitoring the validity of tests and calibrations undertaken... This monitoring shall be planned and reviewed and may include, but not be limited to, the following:*

b) participation in interlaboratory comparison or proficiency-testing programs;"

2.1 Interlaboratory comparison

What is the interlaboratory comparison? In ISO/IEC 17043:2010 standard it is says: "**interlaboratory comparison** is - organization, performance and evaluation of measurements or tests on the same or similar items by two or more laboratories in accordance with predetermined conditions".

So, interlaboratory comparison can be arranged for just two laboratories that have the same scope of accreditation. These two labs are almost always found in a state. Both laboratories have the same goal - the demonstrate competence and can agree on the terms that corresponds for both laboratories. It greatly facilitates the gratification of ISO/IEC 17025, point 5.9, because that is in the interest of both the laboratory and the costs are kept to a minimum - just the cost of transport the measurand from one laboratory to another.

Implementation of the interlaboratory comparison is made in accordance with the requirements of ISO/IEC 17043:2010 standard - from negotiation, making participation schemes to the reporting of results and conclusions.

2.2 Proficiency testing schemes

What are the PT schemes? In ISO/IEC 17043 standard it is says: "***proficiency testing*** *is - evaluation of participant*

performance against pre-established criteria by means of interlaboratory comparisons".

From this definition, it can be concluded that the base of PT schemes is actually interlaboratory comparison with a larger number of participants. The only difference in relation to the interlaboratory comparison is that the organizer of the PT scheme must be accredited according to ISO/IEC 17043 standard. Due to cost accreditation and its maintenance (as well as satisfaction of other conditions required of standards, in the form of equipment) provider must charge a fee for their services from the laboratory participants.

What are the benefits of PT schemes? Proficiency testing provides many benefits to testing and calibration laboratories. The successful completion of a well-designed proficiency test can validate the measurement method, technical training, traceability of standards, and uncertainty budgets of the laboratory. Additionally, proficiency tests can provide a good indication about the quality of the reported results. If the laboratory can successfully complete the directions in the technical protocol for the proficiency test, it is also a good indication that the laboratory does well in following specific customer instructions that may accompany a calibration request.

Conversely, failing a proficiency test can identify nonconformities within the laboratory quality system, and allow the laboratory to improve their processes before the nonconformities come to the attention of the laboratory's customers. Although laboratories do not like failing proficiency tests, most laboratories appreciate the lessons learned in the experience.

How PT schemes are implemented? The typical format of proficiency testing programs is that provider issues a set of samples to each laboratory participant together with a set of instructions and any necessary background information. The participants then carry out the requested analyses in their normal manner and submit their results. The results are then statistically handled by provider to generate a report. Each participant is confidentially provided with a report to allow them to compare their performance with the other participants. The performance of individual laboratories will only be known by that particular laboratory and a limited number of provider management personnel.

The handling of results is generally performed in a manner that compares each individual result with the consensus of the entire group. In the past the statistical handling of results was done by means of calculating averages and standard deviations.

The current method of data handling is in accordance with the ISO/IEC 17043 standard, Annex B.

All this (agreement, procedure, data handling...) can be said also for interlaboratory comparison.

2.3 The availability of PT schemes

Participation in PT schemes enables laboratories to be compared with a number of others and to see where they currently are, ie do need something to change in terms of equipment or in measuring procedure. Therefore increases confidence in the quality of the results, but may increase and the efficiency of the laboratory.

However, if the PT scheme available for all kinds of measurands, ie for all the parameters of certain measurands? The answer is NO. Unfortunately there are still no providers accredited to ISO/IEC 17043 standard for all types of measurands, and the question is when it will be. The reason for this may lies in the fact that certain measurands are difficult to transport, ie that someone must be transported personally to the individual laboratories which greatly increases costs of the proceedings. For example, such is the case with land surveying measurands that are robust, but there are also measurands extremely sensitive to shocks and can not be sent by mail.

The proof that this statement is true can be easily found at any accreditation body website because all those published lists of PT providers and current PT schemes, or suggest laboratory to websites over which they can search accredited PT providers. The most famous, and most complete, list of PT providers and schemes to which indicate all accreditation bodies is EPTIS database (http://www.eptis.bam.de/). Recommend the services of the National Association for Proficiency Testing, NAPT, from USA (http://www.proficiency.org/Services). Simply by asking the aforementioned base of PT schemes can be established that in they are not found all the measurands. For example, for the dimension (including length and angle) in EPTIS database is 10 (14) providers, and NAPT database 18 PT schemes.

Then how do demonstrate competence? The only thing left, and is in accordance with the ISO/IEC 17025 standard, is interlaboratory comparisons.

2.4 Then - why only PT schemes?

All of the above leads to the conclusion that the laboratory can demonstrate competence through interlaboratory comparison. However, accreditation bodies insist on participation in PT schemes, and it is not only the case in Serbia (one can check the websites randomly selected accreditation bodies). In Serbia it became too tightened, so that some laboratory that seek to expand the scope of accreditation may lose existing accreditation if not participated in PT schemes, even if there are no PT schemes of its existing scope of accreditation.

Why is this so?

It seems that accreditation bodies want to protect yourself and above all their status in international organizations, especially the ILAC - the International Laboratory Accreditation Cooperation.

Namely, the ILAC requirements document specifying PT participation is entitled ***ILAC Policy for Participation in Proficiency Testing Activities*** (ILAC-P9). ILAC P9 requires that "*Accreditation bodies (ABs) seeking to sign or seeking to maintain their status as a signatory to the ILAC Multilateral Recognition Arrangement (MRA) shall demonstrate the technical competence of their accredited calibration and testing laboratories. One of the elements by which accredited laboratories can demonstrate technical competence is by satisfactory participation in PT activities where such activities are available and appropriate.*"

Although it is true that participation in PT schemes is ***one*** of the elements to prove competence, accreditation bodies have begun to insist the most on it, neglecting the other option - interlaboratory comparison. Explanation, at least in Serbia, is to interlaboratory comparison can "agree", ie. those laboratories can garble the results. However, this is just an excuse because any serious laboratory has an interest, not only for monitoring the accreditation body, in the confident in their calibration results, and that is possible only by comparing with another laboratory.

3. EXAMPLE - SURVEYING MEASURAND

3.1 Metrological Laboratory of the Faculty of Civil Engineering - ML160

Metrological Laboratory (ML160) of the Faculty of Civil Engineering, Institute of Geodesy, started working on 1985, immediately after the Law on Measuring Units and Measuring Instruments of 1984 had been enacted. This is the first laboratory not only in Serbia but also in former Yugoslavia. For the first time, this Law regulates the issue of (probing) testing of geodetic measuring instruments. According to articles of this Law and the accompanying documents regulating types of instruments that should be tested and periods of re-testing, certain geodetic organizations started bringing their geodetic instruments for testing. In the beginning, only testing of geodetic measuring instruments were carried out, since it had been thus regulated by the Law, and the Certificates of Conformance were issued by the Federal Institute for Measures and Precious Metals (now Directorate of Measures and Precious Metals - DMPM).

By the end of 1994, the Laboratory became an authorized geodetic metrological laboratory which apart from testing of geodetic measuring instruments also issued the Certificates on Conformance. After the changes in legal regulations related to the work of metrological laboratories in 2002, the Laboratory became an accredited metrological laboratory for testing instruments measuring angle and length by the Yugoslav Accreditation Body (YUAB). According to legal provisions, the accreditation decision stipulates all the measuring instruments that can be probed in the ML160 and they are as follows: levelling instruments, theodolites, distance meters (optical, electro-optical and laser), total stations, all types of GPS receivers, tapes and levelling rods (both regular and precise).

After the adoption of new legislation, not only in Serbia but also in the world, Metrology Laboratory is accredited again in 2010, this time according to the ISO/IEC 17025 standard. The scope of accreditation is basically the same as in the previous period. According to the requirements of the same standard, Accreditation Body of Serbia (ABS) has made a couple of annual supervisory assessment. On this occasion there were the individual remarks that are related to the quality management system (contents of some documents, keeping records on paper or in electronic form ...), but not on the methods, procedures and results of calibration.

The main component of the laboratory is adequate measuring equipment tested by DMPM and for which the laboratory has certificates on conformance. Measuring equipment encompasses all fields of action and calibration methods of geodetic measuring instruments: laser interferometrical system, frequency meter, distance meter, level, theodolite, and collimator. The laboratory has the appropriate polygons for calibration - polygon of fixed angles, two polygon of fixed lengths and GPS polygon. Polygons make the properly stabilized concrete pillars at three locations, per five for length and two for the GPS.

3.2 ML160 - demonstration of competence

In his work the ML160 on initially did not have to prove their competence because it was not require any previous regulations, except when applying for license to work (first and later, after the regulation changes). It was only after accreditation to ISO/IEC 17025 standard, accreditation body began looking for proving of competence. It is, by the way, been the case and in other countries.

Since for the geodetic measurands, which are basic measurands that laboratory calibrated, did not exist, and still does not exist, accredited PT provider, the laboratory proved their competence in interlaboratory comparison with related laboratories. Total has participated, to date, in three interlaboratory comparisons with Metrological laboratory of High School of Civil Engineering and Geodesy of Applied Sciences (VGGS). The results have always been satisfactory.

Calibration of distance meter

Intercomparison was performed by determining additive constant of electro-optical distance meters Sokkia SET630R. Both intercomparison participants used the same distance meter and the same corresponding prism provided by the laboratory ML160. The length uncertainty measured by this distance meters, expressed as a standard deviation, is:

$\sigma_d = (a + b \cdot D)$ mm = $(2 + 2 \cdot D)$ mm

where D is the measured length in km.

Additive constant in both the laboratory is determined in the same way - on the basis of measurements of etalon length. In the pilot laboratory ML160 four lengths were measured five times (before and after the intercomparison) and in participant laboratory VGGS one length 192 times. Comparison of the results of determining the additive constant is shown in Table 1.

Table 1: Comparison of the results (all results are in mm)

O. nr.	ML160		VGGS		Difference	
	a_{GF} ML160	Uncertainty U	a_{VGGS}	Uncertainty U	Δa	E_n *number*
1.	0,99	0,70	0,72	1,04	0,27	0,21
2.	0,94	1,00	0,72	1,04	0,22	0,15

The degree of compliance the results of distance meters additive constant determination is calculated according to the formula:

$$E_n = \frac{x - X}{2\sqrt{U^2_{lab} + U^2_{ref}}} \quad (1)$$

where x is the participant result, X is the result of reference laboratory, and $U=s \cdot 2$ are expanded uncertainty of laboratory, respectively. Uncertainty was determined according to ISO 17123-4:2001 standard. The measurement results shown in Table 1 indicate a high agreement of determining additive constant. The difference values of determined additive constant in both the laboratory is about 25%. Given

the value of the additive constant and the measurement uncertainty of its determination in both laboratories, it can be concluded that the calibration determined that there is no additive constant (the constant value is less than the measurement uncertainty).

Calibration of levelling

Intercomparison was performed by determining uncertainty of levelling height difference per length of 1 km. Both participants use the same intercomparison measurand - Leica Geosystems Sprinter 100M, which provided laboratory VGGS.

Calibration was performed using methods:

- DIN 18723, Teil 2 - VGGS,
- ISO 17123-2:2001 - ML160.

Comparison of the results of determining is shown in Table 2.

Table 2: Comparison of the levelling calibration results

ML160	VGGS	Difference
Uncertainty σ_{GF} $\left[\text{mm}/\sqrt{\text{km}}\right]$	Uncertainty σ_{VGGS} $\left[\text{mm}/\sqrt{\text{km}}\right]$	Test of compliance $F=\frac{\sigma_{GF}}{\sigma_{VGGS}}$
0.85	0,78	1,09<2,22

We tested the null hypothesis:

$$H_0:\ \sigma_{GF}=\sigma_{VGGS} \tag{2}$$

versus the alternative hypothesis:

$$H_1:\ \sigma_{GF}\neq\sigma_{VGGS} \tag{3}$$

As the size of the test it is set up the quotient:

$F=\frac{\sigma_{GF}}{\sigma_{VGGS}}$, for $\left(\sigma_{GF}=\sigma_{VGGS}\right)$, where is: $F\approx F(f_1,f_2)\big|H_0$.

Test decision read as follows:

$F\le q$ - accepts the H_0;

$F>q$ - not accepts the H_0, where is $q=F_{1-\alpha}\left(f_1,f_2\right)$.

Comparing the dispersion is obtained: F = 1,09, for the probability of 1-α = 0.95% and the number of degrees of freedom $f_1=f_2=f=2\cdot(n-1)=18$, which means that the results of measurements obtained by participants in the interlaboratory comparison are in accordance.

Calibration of GPS antenna

Intercomparison was performed by determining the variation of the position of the antenna phase center, and comparing the difference. Both intercomparison participants used their base, and the same measurand, LEICA SR20 with antenna Leica AT501, which was provided laboratory VGGS, by the methods:

- VDM 01 - VGGS,
- UNAVCO (2001): UNAVCO Academic Research Infrastructure (ARI) Receiver and Antenna Test Report - ML160.

As a criterion for the assessment was used the expanded measurement uncertainty expressed by EA-4/02, for each group of measurements and method. Degree of compliance was calculated using formula (1).

Table 3: Comparison of the GPS results (all results are in mm)

Results	ML160	VGGS
Antenna phase center variations	Δ_{fcGF}= 4,0 mm	Δ_{fcVGGS}= 4,5 mm
Uncertainty	U = 2,68 mm (k=2)	U = 3,22 mm (k=2)
Degree of compliance E	0,06	

Based on performed interlaboratory comparative measurements above mentioned methods can be concluded that the results were derived from measurements in both laboratory are in accordance.

From all performed interlaboratory comparison deduce that the laboratory ML160, as well as participant laboratories, has demonstrated its competence in the calibration of different types of geodesic measurands.

However, during supervision, the accreditation bodie assessors found a remark that ML160 laboratory did not prove their competence in the ISO/IEC 17025 standard because has not participated in PT schemes, although they are not. Therefore the laboratory was forced to seek similar laboratories in neighboring countries. Thus, the laboratory contacted colleagues from Ljubljana, Slovenia, and has agreed interlaboratory comparison of precision leveling staffs calibration. It will cost laboratory a few hundred euros (travel, accommodation...), unlike the interlaboratory comparison where it was previously participated and who did not cost anything because it was in the interest of other ones laboratories.

4. CONCLUSIONS

The ISO/IEC 17025 standard provides proving competence of calibration laboratories through proficiency testing scheme or interlaboratory comparison. According to standard both methods are equal. However, some accreditation bodies insist on PT schemes and neglect interlaboratory comparison, although no PT scheme for all the measurands and require higher costs.

In the example of the Faculty of Civil Engineering laboratory, ML160, it was shown that through interlaboratory comparison can successfully demonstrate competence, and that at the same time with minimal cost. Based on this, we believe that accreditation bodies should not insist on something that does not exist and that there should accept that which exists and what is better for laboratories, especially which is for some of them participate in PT schemes impossible due to financial status

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